Report of Proceedings

Eastern Experiment Station Collaborators' Conference on DECIDUOUS FRUITS

October 17 and 18, 1961

EASTERN UTILIZATION RESEARCH & DEVELOPMENT DIVISION
AGRICULTURAL RESEARCH SERVICE
U.S. DEPARTMENT OF AGRICULTURE
PHILADELPHIA 18, PENNSYLVANIA

Conference was held at the Eastern Utilization Research and Development Division with representatives from the State Agricultural Experiment Stations, universities, fruit processors and other representatives of industry, National Apple Institute, Quartermaster Food and Container Institute, and the U. S. Department of Agriculture participating.

This report summarizes the discussions of the various speakers during the conference. If further details regarding any particular subject are desired, they may be obtained by communicating with the person concerned (see appended list of names and addresses).

EASTERN EXPERIMENT STATION COLLABORATORS' CONFERENCE
ON DECIDUOUS FRUITS
October 17 and 18, 1961

PROGRAM

Tuesday, October 17

8:30 a.m.	Registration	
9:40 a.m.	Introductory Remarks	P. A. Wells Eastern Utilization Research and Development Division
9:45 a.m.	Breeding Fruit for Processing	L. F. Hough Agricultural Experiment Station New Brunswick, New Jersey
10:35 a.m.	Estimating Maturity for Harvest	F. W. Southwick Agricultural Experiment Station Amherst, Massachusetts
11:25 a.m.	Effect of Apple Maturity on Processed Fruit Quality	R. S. Shallenberger Agricultural Experiment Station Geneva, New York
12:15 p.m.	Lunch	
2:00 p.m.	Recent Research Work on Evaluation of Maturity of Deciduous Fruits	A. P. Sidwell Agricultural Marketing Service Beltsville, Maryland
3:00 p.m.	Mechanical Harvesting of Fruits	J. H. Levin Agricultural Research Service U.S.D.A. East Lansing, Michigan
3:45 p.m.	Quality of Mechanically Harvested Cherries	R. T. Whittenberger Eastern Utilization Research and Development Division
4:00 p.m.	Dehydrofrozen Fruit	J. Brekke Western Utilization Research and Development Division Albany, California

Wednesday, October 18

9:00 a.m.	Objective Measurement of Texture of Food Products	Alina Szczesniak Research Center General Foods Corporation Tarrytown, New York
10:00 a.m.	Evaluation of Market Potentials for New Fruit Products	Marshall E. Miller Economic Research Service U.S.D.A. Washington, D. C.
11:00 a.m.	Objectives of the Fruit Processing Industry	Carl Smith Gerber Products Company Fremont, Michigan
12:00 Noon	Lunch	

2:00-4:00 p.m.
Tour of Laboratory:

Taste Panel Room

1. Powdered Apple Juice
2. Instantized Dehydrated Vegetables
3. Apple Juice - West Virginia
4. Apple Chips - West Virginia.

Pilot Plant

1. Instantizing Operation
2. Continuous High Vacuum Dryer

Laboratory

1. Amino Acid Analyzer
2. Respiration of Fruit
3. Apparatus for Measurement of Fruit Quality - A.M.S.

INTRODUCTORY REMARKS

by
P. A. Wells
Eastern Utilization Research and Development Division

Dr. Wells welcomed the delegates to the Conference. He pointed out that the topic of the present Collaborators' Conference, Deciduous Fruits, was decided upon at a meeting of the Northeastern Agricultural Experiment Station Directors held in New York this Spring. In past years a number of conferences held here have been devoted to deciduous fruits. Other conferences that were started here as Collaborators' Conferences, such as the potato, tobacco, and milk concentrates conferences, have been continued elsewhere on an annual basis by interested representatives of their respective industries. A conference report containing summaries of the papers presented at the present meeting will be prepared and each delegate will receive a copy, together with a photograph of the group. Extra copies of the report will be furnished on request.

BREEDING FRUIT FOR PROCESSING

by
L. Fredric Hough
New Jersey Agricultural Experiment Station
New Brunswick, New Jersey

We have the opportunity and we have an obligation to define the nature of the fruit industry of the future, for the nature of new products and new methods of preparing these products for the consumer will, in large measure, depend upon the characteristics of the new varieties available to the processors. Our specifications for ideal new varieties are limited by what we know about the total variability for each kind of fruit, by our ambition, and by our concepts of what might be valuable or useful to the industry 10 or 20 years from now.

We need a wealth of plant material so we can visualize new combinations of characters, and we need objective methods for measuring our progress. We want suggestions, especially from producers and processors, with respect to the ultimate goals, i.e., new combinations of characters that would benefit the industry. Remember that it usually takes years of persistent, consistent work to combine desired new characters into acceptable horticultural varieties.

In our efforts to combine quality characteristics and to eliminate undesirable factors, we will be guided by our broad objective to provide better food for more people at the lowest possible cost. The current increased consumption of convenient-to-use food items will continue and will in turn cause a great deal more emphasis to be placed on breeding varieties for processing.

Marketing and processing seasons must be extended with respect to time and location. The next two or three decades will bring about considerable changes in our fruit industry and present standards may not be acceptable in the future. These changes will result from the combined efforts of all segments of our fruit economy. The, breeder, more than any other professional person, should anticipate the nature of these changes.

The rapid growth of the frozen food industry has already modified objectives in fruit breeding. High initial flavor is not necessarily required for freezing preservation. As long as the fruit looks good and has an acceptable taste, other factors may become more important such as the ability to retain a firm texture throughout the freezing and thawing process.

Horticultural characters such as yield, disease resistance, insect resistance, and maturity dates will, of course, continue to be important in our breeding programs. Other characteristics will receive attention such as suitability for mechanical harvest and for use in blends. If better processed products can be obtained through the blending of raw materials, fruit breeders can supply varieties with the desired unique qualities. The blending of varieties is already employed in the production of apple juice and apple sauce.

In the future we will witness the production of some fruits in new or currently small-producing areas. In Eastern North America apricots and nectarines will be grown commercially and cling peach and pear production will be increased. Industry and other government agencies, including the Eastern Utilization Research and Development Division, are cooperating in the development of objective methods for measuring progress in breeding peaches suitable for processing.

In summary, our future achievements in fruit breeding will be determined largely by what we try to do and by the limits that are placed on our imagination.

ESTIMATING MATURITY FOR HARVEST

by

F. W. Southwick
Massachusetts Agricultural Experiment Station
Amherst, Massachusetts

In Massachusetts apples are raised primarily for the fresh fruit market. Of the varieties grown McIntosh predominates. Consequently, our work on maturity standards for harvesting apples is related to McIntosh to be sold fresh from either regular refrigerated storages in air at 30°F. or from controlled atmosphere (CA) rooms at 38°F. with carbon dioxide levels at 3 to 5 per cent and the oxygen content at about 3 per cent. About half of

the stored McIntosh crop is now held in CA storages. With these two types of storages, fresh McIntosh apples are now being sold from September to July (about 10 months a year). Obviously, one would not expect that any single harvest date would be best for this variety when it is sold over such an extended period of time.

The principal characteristics that CA McIntosh should have when they come on the market from February to July are that they have sufficient red color to meet the fancy grade requirements, are firm and juicy, and are free from storage scald. Our data of the past 3 years show that, in order to have such fruit available in the spring from CA rooms, McIntosh should be picked at a flesh firmness which averages not less than 15 pounds (15 to 17 pound range) as determined by a Magness-Taylor pressure tester with a 7/16-inch head. In order to obtain such firm McIntosh for CA storage, which have sufficient red color to meet the fancy grade requirements, usually means that growers must spot pick for red color. Our data and experience show that if one must choose between red color and firmness that red color should be sacrificed rather than condition as far as CA McIntosh are concerned.

It appears that picking McIntosh apples for CA must start about one week ahead of picking for cold storage. In Massachusetts, harvesttime for cold storage McIntosh invariably commences about September 15 to 20. For cold storage McIntosh that are to be held from December to February, we suggest that fruit be no softer than a 14 pound average. Of course, scald is apt to be more severe on early picked fruit placed in cold storage. Fortunately, the reverse is true for McIntosh put in a CA room. In addition to early picking, in order to keep scald under control on CA McIntosh, it is necessary to move the fruit rapidly to storage after harvest (within 24 hours) and remove the field heat quickly once the fruit has reached the storage.

This method of determining time of harvest lacks some of the advantages of forecasting systems for harvest such as days from full bloom, calendar date, or the use of heat unit summation methods since it depends upon on-the-spot decisions as the apples ripen. However, in our area such things as the weather and nutritional status of the trees vary tremendously from year to year and from tree to tree, respectively. These variations obviously influence important maturity factors considerably and can seriously upset the reliability of forecasting systems.

Red color development on the surface of McIntosh apples is largely dependent upon cool night temperatures in September and the nitrogen status of the trees. Unusually warm weather up to mid-September in both 1959 and 1961 greatly impeded red color development and made delays in harvest mandatory even though other indices of maturity indicated that it was time to pick the fruit. Fortunately, we have been far enough north so that McIntosh of desirable firmness and color have been obtainable to date but in areas to the south our suggested harvesting procedure, like others, might fail.

Variations in nitrogen level of apple trees may seriously upset maturity standards, also. In comparison with fruit from trees maintained at low to moderate levels of nitrogen, high nitrogen levels tend to delay both red and ground color development of apples. Fruit from high nitrogen trees, although possessing a greener ground color, respire at a higher rate and are softer on a given calendar date at harvesttime than fruit from trees at a lower nitrogen status (but above deficiency levels).

EFFECT OF APPLE MATURITY ON PROCESSED FRUIT QUALITY

by
R. S. Shallenberger
Agricultural Experiment Station
Geneva, New York

As a matter of convenience, apple growers in New York State normally started to harvest the variety Rhode Island Greening apples for processing around the first or second week in September. Studies initiated at Geneva, New York, in 1956 regarding apple maturity as related to processing quality showed that this variety, considered the most important processing apple in the area, reached minimum maturity for processing about October 1, and not early September.

During the course of the maturity and processing studies underway at Geneva, various objective measures of maturity, as indicated by the processing quality of the fruit, were investigated. The three factors that were of prime importance are the pressure test, the brix-acid ratio, and heat units. Pressure test readings were obtained using a Magness-Taylor instrument and 4 tests on each of 25 apples in a sample were obtained and averaged. Brix (total soluble solids) was measured by refractometer on the juice expressed from the halves of 25 apples, and the percentage total acid content, expressed as malic acid, was determined on the same juice by titration to pH 8. The calculation of Heat Units consisted essentially of a non-linear method based on the assumption that apples mature more rapidly at a mean daily temperature of 65°F. At mean daily temperatures above and below 65°F. the rate of apple maturation is proportionately slower.

It was found that the quality of the processed products from apples left on the trees until about October 1 was markedly superior to that of products prepared from apples that had been harvested earlier. As a result of the maturity and processing studies, it appeared that optimum pack products could not be obtained until the following objective values for processing maturity were obtained.

Pressure test	15-20
Brix-acid ratio	15-20
Heat Units	3000

The findings were judged to have possible important application to the New York apple processing industry, and the decision was made to apply the results on a commercial scale; the primary object--to upgrade the quality of processed apple products by carefully selecting the approximate harvest date when the variety would begin to yield Fancy pack processed products.

In 1960, 12 orchards representing 60,000 bushels of apples were selected for this large-scale study and weekly samples were taken for recording the pressure test and Brix-acid ratio. Samples from 4 especially designated orchards were taken at weekly intervals for processing as canned apple slices.

As indicated by the objective indices, the growers were informed when their fruit would reach minimum maturity for Fancy pack processing with some certainty two weeks before harvest should begin, and with absolute certainty one week before harvest should begin.

As the harvest time was delayed from the usual September dates, the color of the apple slices improved from a dull-green cast through yellow, and finally a gold cast resulted. Flavor improved from "very tart" to a good, well balanced apple flavor. All apples handled in this manner were harvested October 5-19 and were processed as a "Fancy" pack.

Nearly the entire industry followed this program this year (1961) and the quality of the processed products is judged to be about the highest it has ever been.

RECENT RESEARCH WORK ON EVALUATION OF MATURITY OF DECIDUOUS FRUITS

by

A. P. Sidwell
Agricultural Marketing Service
Beltsville, Maryland

Recent work of our research group has centered around the use of light transmittance techniques to estimate fruit maturity. This method, which has been referred to as the "Horticultural Spectrophotometer" method, is non-destructive and can be applied to individual, intact fruits at a rapid rate. The basic technique consists in measuring and characterizing the light energy transmitted through intact products, and has application to a number of agricultural commodities.

The first organized work with deciduous fruits was on the prune-type plum. In this work we used an instrument built to read in terms of wavelength of peak light transmittance. We found that this reading progressed from about 545 millicrons (μ) in green fruit to about 630 μ in tree-ripe fruit. Measurements taken by this instrument correlated well with other indices

of maturity of prune-type plums, including Hunter A readings, shear resistance, and the soluble solids to acid ratio. The readings of wavelength of peak light transmittance were found to be quite reproducible.

The Horticultural Spectrophotometer used in the work on plums measures the combined effect of accumulation of certain fruit pigments during maturation, such as carotenoids and xanthophylls and the destruction of others, in particular, chlorophyll. Whereas this method appeared to be suitable for use in prune-type plums where there is not much color difference among the different varieties, it might not be suitable for peaches which have more varietal differences. For this reason, a different approach was used for the peach work and for the apple project which followed later. This approach was based upon the measurement of the decrease in chlorophyll with increasing maturity which has been shown to occur in peaches. Chlorophyll shows a very strong absorption at about 675 μ with our intact fruit spectrophotometer. The difference between the optical density, measured at near this wavelength and the optical density at some other region, relatively insensitive to chlorophyll changes, is an effective measure of chlorophyll. The calculation of difference in optical density between two wavelengths Δ O.D. (l_1 - l_2) also reduces the error due to fruit size, position and other variables. This measurement is considered to be fairly free from interference of other plant pigments. In samples which are widely different in chlorophyll content the measurement is usually made at about 695 to 700 μ, since the chlorophyll absorbance of very immature fruit may be beyond instrument sensitivity. Results of research showed a high linear correlation between the Δ O.D. (700 μ - 740) and the chlorophyll content expressed as the logarithm of the chlorophyll in micrograms per gram of fresh weight. Since the log of chlorophyll content declined linearly as harvest date progressed, there was also high correlation between Δ O.D. (700 μ - 740) and harvest date.

Work on the evaluation of maturity of apples has been based on measurement of the decline of chlorophyll content using about the same Δ O.D. measurement. Light transmittance of a large number of individual apples was measured and the chlorophyll extracted. The resulting data show a high correlation between the Δ O.D. measurement and chlorophyll content as determined by chemical analysis. These data also serve as a basis for calibrating the portable instruments designed and built to use away from the Beltsville laboratory.

On the basis of work on peaches and apples, it was concluded that the instrument measurements of chlorophyll content Δ O.D. (700 μ - 740) were related to maturity.

Our work on the spectrophotometric evaluation of anthocyanin pigment development and condition of scald in Red Tart cherries indicated that measurements to evaluate anthocyanin development should be made in a shorter wavelength region, at around 540-560 millicrons, and that a Δ O.D. between this measurement and one at above 600 μ should be calculated. Early in this work it was discovered that bruising and holding cherries at

high temperatures caused higher readings than could be justified by the true anthocyanin content of the fruit. Work on this problem shows that measurements at longer wavelengths can be used to evaluate the condition of scald which results from bruising and holding. These measurements are thought to be sensitive to the turbid condition of the internal contents of damaged cherries. Therefore, they might serve to evaluate the condition of cherries and could be followed by a shorter-wavelength measurement of anthocyanin to complete the quality evaluation job.

MECHANICAL HARVESTING OF FRUITS

by
Jordan H. Levin
Agricultural Research Service
United States Department of Agriculture
East Lansing, Michigan

Mechanical harvesting of fruits is a new concept. In fact, only 4 years ago about the only research on this subject was being conducted by the United States Department of Agriculture in cooperation with Michigan State University, University of California at Davis and the University of Washington at Wenatchee.

Today the picture is different. We find fruit harvesting research being planned or conducted also at the University of Florida, Cornell University, Pennsylvania State University, Oregon State University, Ohio State University, University of Connecticut, University of Maine, and the University of Arizona. Equipment manufacturers also are conducting research.

You should be interested in mechanical harvesting because it will affect most of you directly or indirectly. You will have to live with new problems and solve them. Mechanical harvesting is not wishful thinking--it is already here for some crops and will come for almost all crops which are processed.

The Need. The need for mechanical harvesting has resulted from high picking costs and critical labor problems. In some crops, such as cherries and blueberries, harvesting costs amount to about 50% of the total cost of production. The bulk of the fruit crop is now harvested by labor brought in from outside the producing area. About 425,000 migratory farm workers (mostly from the Southern states) and 460,000 foreign nationals (mostly Mexicans, Jamaicans, and Bahama Islanders) are required for harvesting the fruit and vegetable crops of this country. Recruiting, housing, and managing these temporary workers are difficult and sometimes almost impossible tasks.

A new incentive to mechanization was supplied by the activities of the labor unions in 1960. In some cases in California strikes among pickers prevented growers from harvesting their crops.

Problems. Mechanization will bring many changes and new problems. Changes in handling and processing procedures may be required to maintain quality. Maturity of fruit will assume added significance. New varieties and new pruning practices will enter the picture. Sorting procedures and grade standards may have to be changed. Modifications in storage facilities, rate of processing, and time of processing can be expected. New products will be developed.

Results to Date. Our United States Department of Agriculture group is carrying out harvesting research on tart cherries, sweet cherries, blueberries, plums, prunes, grapes, dates, apples, peaches and pears. With tart cherries we are finding that under conditions existing in many orchards, mechanical harvesting equipment, consisting of a tree shaker and catching frames, enables 6 men to do the work of 33 hand pickers. With blueberries, about 25% of the crop in Michigan and 15% of that in New Jersey were harvested mechanically this past year. Labor costs were reduced from about 8 cents per pint to about 4 cents.

Prunes are being harvested mechanically in commercial practice. Three workers can harvest 60 trees per hour at costs of about $2 per ton as compared with $12 per ton for hand harvesting. Plums also are well suited for mechanical harvesting.

Mechanizing the harvest of the clingstone peach, apple, and pear is still in the experimental stage. Although bruise damage to the peach is increased slightly, some lots have been suitable for processing. This fall we harvested 200 bushels of apples an hour with 3 men at a cost of 1-1/2 cents per bushel. The apples are now in storage and will be processed later.

Mechanical harvesting is in its infancy. Our search for better equipment and methods will continue. Success depends upon you as well as upon us. We hope you are sympathetic and are willing to do what you can to help the development.

QUALITY OF MECHANICALLY HARVESTED CHERRIES

by

Robert T. Whittenberger
Eastern Utilization Research and Development Division

In 1958 Levin and co-workers in USDA showed that about 95% of the fruit on a tart cherry tree could be separated quickly from the tree by mechanical means. This accomplishment indicated the feasibility of mechanizing the cherry harvest and initiated the development of many new types of harvesting equipment.

In extending this work, utmost attention is being directed toward obtaining a proper balance between harvesting efficiency and quality of harvested

fruit. Quality must be maintained if mechanization is to be successful. New equipment and new handling procedures are being evaluated for their effects on quality. Bruising is being traced with respect to origin, extent, and time of occurrence, and corrective changes are being made according to the findings. Progress is steady. In 1961, for instance, a new collecting device, equipped with a series of cloth baffles and sponge rubber padding, reduced bruising to a level comparable to, if not less than that of hand picked cherries.

Quality Variations. Since machine picked cherries are a new product, it is not surprising to find wide variations in quality. Methods of harvesting, handling, and processing have not yet been standardized. Experience extending over many seasons will be required to weed out faulty techniques and establish optimum procedures. The needs for each orchard may have to be ascertained.

Grade scores of unsorted mechanically harvested cherries have ranged from 96% to 79% of U. S. No. 1 fruit. It is particularly gratifying to have obtained some lots of excellent quality from large scale commercial trials. The results prove at a very early stage in the new development that quality can be maintained. On the average, however, quality and processing yields have been slightly lower than those of comparable hand picked lots.

Quality Control. Specific causes for variation in quality are many. Quality may be lowered if (1) a high proportion of cherries on a tree are defective, (2) significant numbers of stems remain attached to the harvested fruit, and (3) harvest bruising becomes excessive. Various procedures for sorting out defective cherries are being explored, and the effectiveness of various stemming machines is being tested.

Harvest bruising may be reduced by (1) eliminating hard surfaces and pocketing of fruit on the collecting device, (2) avoiding excessive handling of fruit, (3) using personnel who work carefully and have a soft "touch," (4) delaying harvest until fruit is mature, (5) slowing the rate of harvest, particularly if a tree is heavily loaded, (6) suspending harvesting operations on hot afternoons, and (7) avoiding pole-thrashing of fruit during clean-up operations.

It is our aim in this development to maintain quality at a high level while greatly increasing the efficiency of harvest. With the continued cooperation and assistance of growers and processors we are confident this goal can be attained.

DEHYDROFROZEN FRUIT

by
J. Brekke
Western Utilization Research and Development Division
Albany, California

The first description of a method for preserving fruits and vegetables combining dehydration and freezing appeared in 1946 in Food Industries, entitled "Dehydrofreezing -- New Way of Preserving Food," by Louis Howard and Horace Campbell. This paper described experiments on Royal Anne cherries, boysenberries, apricots, and several vegetables.

In 1949 U. S. Patent 2,477,605 covering dehydrofreezing was granted to the Secretary of Agriculture, with Howard, Ramage, and Rasmussen as assignors. In a 1950 paper Talburt, Walker and Powers gave details for dehydrofreezing apples.

The dehydrofreezing process consists of the following steps:

(1) Conventional preparation of the commodity the same as for canning or freezing. The fruit is washed, peeled, trimmed, sorted, inspected, and sliced. Uniform piece size is important in dehydrofreezing in order to obtain uniform drying.

(2) Inactivation of enzymes by heat, SO_2, or ascorbic acid.

(3) Drying at atmospheric pressure. The drying is carried out rapidly and to the extent necessary to reduce the weight and volume by at least one-half. Where the properties of the commodity indicate, the drying process is carried out in two phases. The two drying phases differ in the rate at which water is released from the solid material. During the first phase, the amount of water evaporated per unit area per unit time is constant. During the second phase, called the "falling-rate" period, the amount of water evaporated per unit area per unit time decreases steadily. The constant-rate drying period is used with materials that are fairly high in moisture content and reflects conditions where evaporation at the surfaces is readily supplied with moisture from the interior of the fruit piece. The principal rate determining factors in the constant-rate period are temperature, humidity, and air velocity; rate of transfer of moisture from the interior to the surface of the piece is not significant. The falling-rate period begins when the water cannot be supplied to the evaporating surface from the interior as fast as water vapor can be removed from the surface. For most commodities that lend themselves well to dehydrofreezing, drying to 50% of the fresh weight involves only the constant-rate period. Tunnel and belt-trough driers have been used in the drying.

(4) Freezing, packaging, and storage. These steps are carried out similarly to the corresponding ones with conventional frozen foods. The

fruit should be frozen quickly and then stored at 0°F. or below. All dehydrofrozen fruits to date have been packaged for institutional use or remanufacture in 5 and 30 pound containers.

The most rapid procedure for determining the extent of dehydration in a fruit is to use a refractometer to determine the soluble solids. A 50 g. sample is blended with an equal weight of water, and soluble solids are determined in terms of sucrose.

Varietal and maturity factors influence the quality of dehydrofrozen fruits. Winesap, Yellow Newtown, Greening, Baldwin, and Northern Spy apple varieties, which are good for canning and freezing, are also quite suitable for dehydrofreezing. Apples should be fully matured or, if harvested in an immature condition, held to permit additional ripening. Apricots should be ripe but not excessively soft.

Dehydrofrozen apple slices have been processed in New York State for the past few years and are probably now being manufactured in the amount of several million pounds annually. Dehydrofrozen cherries may be commercialized in the near future. All dehydrofrozen apple slices, to the best of our knowledge, are now used in pies.

Dehydrofrozen fruits offer the following advantages over ordinary frozen products: weight and volume reduction; lower cost of freezing, packaging, handling and shipping; less drip on thawing; and easier moisture control in remanufacturing. Dehydrofrozen fruits have the following advantages over regular dehydrated fruits: better flavor, color and texture.

OBJECTIVE MEASUREMENT OF TEXTURE OF FOOD PRODUCTS

by
Alina S. Szczesniak
General Foods Corporation
Tarrytown, New York

Objective methods of texture measurement may be divided into three main categories -- fundamental, empirical, and imitative. The fundamental tests measure rheological properties such as viscosities, elastic moduli and relaxation times. An example is the vector test, which consists of compressing or stretching pieces of material under controlled conditions and calculating viscosities, moduli, and relaxation times from deformation curves. Often the tests must be conducted under various conditions of time, temperature and stress to measure a continuous "spectrum" of these values.

The empirical tests measure parameters which practical experience indicates to be related to textural quality. Penetrometers, such as the Bloom gelometer, the Boucher jelly tester, the fruit pressure tester, the

A.S.T.M. grease penetrometer, and the "plumit", measure rigidity of gels and other materials as the force required for a given penetration, or consistency of semi-solid products as the resistance to sinking. Compressors, used to measure hardness or firmness as the resistance to a compressing force, include the Delaware jelly tester, the Brinell hardness tester, the ball compressor for cheese, the Baker compressimeter and the Balance Type compressimeter for bread. The General Foods Corporation has developed a Gel Characterization apparatus which measures the force-deformation characteristics of gel systems. Consistometers are used to make empirical tests on liquids or semi-solids and include such instruments as the Bloom consistometer, the Bostwick consistometer for catsup, the MacMichael viscosimeter, and the Brookfield viscosimeter. Shearing devices measure the empirical characteristic of "tenderness" by recording the force needed to shear the test material. Examples are the Warner-Bratzler apparatus for meat, the pea tenderometer, and the shear press. Miscellaneous instruments of the empirical type include the succulometer, which measures juiciness; the Food Mincer, which measures resistance to grinding; and the fiberometer, which is used for fibrous products like asparagus.

The instruments in the imitative category are designed to imitate the conditions to which the material is subjected in practice. The Butter Spreaders imitate the action of spreading butter on bread. The Brabender-Farinograph and the Alveograph measure the handling properties and strength of dough. The Volodkevich bite tenderometer simulates biting on a piece of food, using two wedges with rounded points as a substitute for teeth. The MIT Tenderometer uses a complete set of human teeth in a mechanical arrangement which imitates the process of biting and chewing the food. The resistance of the food to the process of mastication is detected with a strain gage.

Research on texture conducted at the Research Center of General Foods Corporation concerns itself with development of methods for measuring a spectrum of textural parameters rather than one isolated characteristic. The MIT Tenderometer was selected as the instrument meeting their requirements most closely. The instrument underwent considerable modification. The dentures were replaced with a plunger, the food placed in a cup under the plunger, and the position of the sensing element and the method of recording were changed. Mechanical characteristics of texture were divided into the parameters of hardness, cohesiveness, fluidity, elasticity, and adhesiveness. Cohesiveness is difficult to perceive organoleptically and is usually reported as a composite of two or more of the other characteristics, i.e., the secondary parameters of brittleness, chewiness, and gumminess. The General Foods texturometer, at present, can measure four out of the five primary characteristics, and work is currently in progress on an attachment which will also measure fluidity. From the curve obtained from the instrument, values for hardness, cohesiveness, brittleness, chewiness, adhesiveness, elasticity, and gumminess can be obtained. The same system of nomenclature was adopted for organoleptic evaluation. A texture profiling panel was trained which combines the analytical approach

of flavor profiling with the developed texture terminology and the use of well defined scales. Excellent agreement was obtained between the texturometer values and the texture profiling panel.

EVALUATION OF MARKET POTENTIALS FOR NEW FRUIT PRODUCTS

by
Marshall E. Miller
Economic Research Service
Washington, D. C.

Two new apple products, superconcentrated apple juice and dehydrofrozen apples, have recently been tested to determine the economic feasibility of their commercial introduction.

A market test which ran for approximately 3 months was conducted on superconcentrated apple juice in 23 supermarkets in Fort Wayne, Indiana. Weekly sales in all stores averaged 3-1/3 cases per week. For a 4 weeks promotion period, the rate was 6.1 cases. The case rate sale during the 6-week period following promotion averaged 1.5 cases per store per week.

In the freezer cabinet, the test product, during the promotion period, ranked fourth in 24 items. It was outsold only by 2 brands of orange juice and 1 brand of lemonade. Our product actually outsold, during the 4-week promotion period, the combined sales of 17 of the 24 items audited in the frozen juice cabinets. During the 6 weeks when no promotion took place, the product's sales position moved from fourth to seventh. Even without benefit of promotion the new product managed to outsell for that 6-week period 17 items and the combined total of 11 of these frozen juice items in the freezer cabinet.

When compared to single-strength canned juices, superconcentrated apple juice compiled an even more impressive sales record. Here we find the test product ranking second among 29 items during the 4-week promotion campaign. Superconcentrated apple juice actually outsold the combined total of 21 out of the 29 single-strength juice items audited. In the 6-week post-promotion period, with no promotion help, the test product ranked sixth out of 29 single-strength juice items.

A product test was conducted among bakers in Philadelphia, Baltimore and Washington on dehydrofrozen apple slices to assist the apple industry in appraising the market potential for this product.

The fieldwork on this study has only recently been completed and the data collected have not yet been analyzed. Preliminary tabulation discloses that 52 per cent of the total fruit used by bakers in the samples was apple. Approximately two-thirds of the cooperators who used the

dehydrofrozen apple slices found them to be acceptable in their bakery operation. To substantiate this, many bakers offered advantages of dehydrofrozen apple slices over the form of apple they generally used. Respondents in most instances cited the high quality of the product as its most outstanding feature.

Products made from dehydrofrozen apple slices had the quality characteristic of being eye-appealing. The factor of taste is an important attribute in measuring the product's quality. The majority of respondents questioned found dehydrofrozen apple slices had an excellent taste--superior to any forms of apple they currently used. Respondents indicated that they liked the product for its quality of always being uniform and consistent. Cooperators substantiated this latter statement in the following ways: All the apple slices were approximately the same size, all were the same color, and because it is a frozen product, they are assured of a supply of fresh-like apples of uniform quality the year round. Also, since the water content of the dehydrofrozen apple slices is known, cooking procedures are always the same, and therefore end products are always alike in texture. In addition, respondents cited advantages such as savings in freezer storage space, and economies in handling and transportation. Another point of interest is that at the time this research was initiated there was only one processor of dehydrofrozen apples in existence. At present there are three processors in operation and others have indicated an intention of entering this field at an early date.

OBJECTIVES OF THE FRUIT PROCESSING INDUSTRY

by

Carl Smith
Gerber Products Company
Fremont, Michigan

Our past progress in agriculture has been largely the result of effective research programs. Production research has paid great dividends and has made us the best fed nation in history. This fact has also led our nation into a complacent indifference towards food and, in fact, towards agriculture and agricultural research. We all have a responsibility in impressing our people with the contribution of agriculture to our national welfare. Failure to impart the proper "image" of agriculture to the public is responsible for an alarming decrease in the number of graduates from Land-Grant Colleges. In 1950, 10,908 degrees were granted in agriculture; in 1958 there were 5,525 graduates. A continuation of this trend would result in 3000 graduates in 1970 whereas our current needs for trained students in "Agri-Business" is 15,000 each year.

In general, the objectives of the fruit processing industry are to offer our consuming public (which is all of us) the best quality processed products possible, free from all foreign material, safe from harmful residues

and additives, at the most economical price possible. Although subject to individual interpretations, quality generally refers to flavor, color, appearance, texture, shape, and all those other factors that enable the consumer to enjoy our processed items. The processing industry needs dependable volume sources of high processing quality produce. In many instances our quality requirements are more specific and detailed than those for the fresh market. Processors cannot improve the quality of the raw material and we have no secret formulas to make a Grade A product out of inferior raw materials. The key to high processing quality produce is efficient, profitable growing operations, and it involves a multitude of answers including proper varieties, growing locations, cultural practices, harvesting and handling equipment and techniques.

It is impossible to draw a line between the grower and processor and neither can prosper without the other. The function of processing is to provide a service of preserving and distributing a major portion of the fruit crop, and the success of the industry is dependent upon successful growers and successful processors with common interests. It is imperative that we understand each other's problems and be willing to do something about them. As a prelude to this talk I contacted 40 leaders in our industry to solicit their thoughts on this subject. We believe that current work in all of the following problem areas should be expanded: Breeding programs for processing characteristics (in which suitability for a number of processed products is evaluated), disease resistant varieties, root stock and variety clarification, nutritional diagnosis, growth regulators and thinning materials, increased pear and peach production in the East, control of brown rot on peaches, mechanical harvesting and handling, determination of harvest maturity for processing, objective measurement of quality, crop estimating, hydrocooling, post-harvest physiology, optimum storage for processing, and development of new fruit products.

Finally, better communications are needed between the processing industry and research workers. It is physically impossible for us in the industry to contact all the research people in an effort to determine what they may be doing that applies to us. The Raw Products Research Committee of the National Canners Association, with headquarters at 1133 20th Street, N. W., Washington 6, D. C., is ready and willing to cooperate and assist in your research programs. This liaison could include the furnishing of such information as variety and quality requirements of our industry. Our packers could furnish samples of products for use as standards. This agency is offered as an effective contact with our 4.7 billion dollar industry. Our volume will have to be increased by about 28% by 1975 just to keep pace with our population increase.

LIST OF ATTENDANCE

Name	Organization	Address
Bailey, Catherine	New Jersey Agric. Expt. Sta.	New Brunswick, N. J.
Bobb, A. C.	University of Connecticut	Storrs, Conn.
Brekke, J. E.	Western Util. Res. & Devel. Div.	Albany, Calif.
Buch, Margaret L.	Eastern Util. Res. & Devel. Div.	Philadelphia, Pa.
Christopher, E. P.	Rhode Island Agric. Expt. Sta.	Kingston, R. I.
Cording, J., Jr.	Eastern Util. Res. & Devel. Div.	Philadelphia, Pa.
Craig, H. M.	Tasty Baking Company	Philadelphia, Pa.
Crosby, E. A.	National Canners Association	Washington, D. C.
Curwen, D.	Pennsylvania State University	University Park, Pa.
Davis, D. R.	Ohio Agric. Expt. Sta.	Wooster, Ohio
DiMarco, G. R.	Rutgers University	New Brunswick, N. J.
Eisenhardt, N. H.	Eastern Util. Res. & Devel. Div.	Philadelphia, Pa.
Eskew, R. K.	Eastern Util. Res. & Devel. Div.	Philadelphia, Pa.
Harrington, W. O.	Eastern Util. Res. & Devel. Div.	Philadelphia, Pa.
Highlands, M. E.	Maine Agric. Expt. Sta.	Orono, Me.
Hills, C. H.	Eastern Util. Res. & Devel. Div.	Philadelphia, Pa.
Hitz, C. W.	Pennsylvania State University	University Park, Pa.
Hough, L. F.	New Jersey Agric. Expt. Sta.	New Brunswick, N. J.
Johnson, K. R.	Quartermaster Food & Container Instit.	Chicago, Ill.
Kennard, W. C.	Cooperative State Expt. Sta. Service	Washington, D. C.
LaBelle, R. L.	New York State Agric. Expt. Sta.	Geneva, N. Y.
Larsen, R. P.	Michigan State University	East Lansing, Mich.
Lawver, K.	C. H. Musselman Co.	Biglerville, Pa.
Levin, J. H.	Agricultural Research Service	East Lansing, Mich.
Lopez, A.	Virginia Agric. Expt. Sta.	Blacksburg, Va.
Lothrop, R. E.	Eastern Util. Res. & Devel. Div.	Philadelphia, Pa.
Lott, R. V.	Illinois Agric. Expt. Sta.	Urbana, Ill.
Marsh, R. S.	West Virginia Agric. Expt. Sta.	Morgantown, W. Va.
Martin, D. C.	Kentucky Agric. Expt. Sta.	Lexington, Ky.
Mattus, G. E.	Virginia Agric. Expt. Sta.	Blacksburg, Va.
McArdle, F. J.	Pennsylvania Agric. Expt. Sta.	University Park, Pa.
McMarlin, J. B.	National Apple Institute	Washington, D. C.
Meschter, E. E.	American Stores Company	Philadelphia, Pa.
Miller, M. E.	Economic Research Service	Washington, D. C.
Miller, V. E.	National Fruit Product Co.	Winchester, Va.
Mitchell, A. E.	Michigan Agric. Expt. Sta.	East Lansing, Mich.
Oberly, G. H.	Storrs Agric. Expt. Sta.	Storrs, Conn.

Name	Organization	Address
Perry, J. S.	University of Massachusetts	Amherst, Mass.
Pollack, R. L.	Eastern Util. Res. & Devel. Div.	Philadelphia, Pa.
Reynolds, B. C.	Cooperative State Expt. Sta. Service	Washington, D. C.
Ritter, C. M.	Pennsylvania State University	University Park, Pa.
Roberts, N. E.	Eastern Util. Res. & Devel. Div.	Philadelphia, Pa.
Satori, Kathryn G.	Eastern Util. Res. & Devel. Div.	Philadelphia, Pa.
Schubert, O. E.	West Virginia University	Morgantown, W. Va.
Shallenberger, R. S.	New York State Agric. Expt. Sta.	Geneva, N. Y.
Shockey, H.	National Fruit Product Company	Winchester, Va.
Sidwell, A. P.	Agricultural Marketing Service	Beltsville, Md.
Sills, M. W.	Economic Research Service	Philadelphia, Pa.
Smith, C. G.	Gerber Products Company	Fremont, Mich.
Smith, W. W.	New Hampshire Agric. Expt. Sta.	Durham, N. H.
Southwick, F. W.	Massachusetts Agric. Expt. Sta.	Amherst, Mass.
Strolle, E. O.	Eastern Util. Res. & Devel. Div.	Philadelphia, Pa.
Szczesniak, Alina	General Foods Corp.	Tarrytown, N. Y.
Tan, C. T.	Continental Baking Co., Inc.	Rye, N. Y.
Thompson, E. R.	Agricultural Marketing Service	Washington, D. C.
Treadway, R. H.	Eastern Util. Res. & Devel. Div.	Philadelphia, Pa.
Weckel, K. G.	University of Wisconsin	Madison, Wisc.
Wells, P. A.	Eastern Util. Res. & Devel. Div.	Philadelphia, Pa.
Whittenberger, R. T.	Eastern Util. Res. & Devel. Div.	Philadelphia, Pa.
Wiley, R. C.	Maryland Agric. Expt. Sta.	College Park, Md.
Wing, R. E.	Tasty Baking Company	Philadelphia, Pa.
Woodward, C. F.	Eastern Util. Res. & Devel. Div.	Philadelphia, Pa.
Yeatman, J. N.	Agricultural Marketing Service	Beltsville, Md.